- Chapter 31
- The Child with a Metabolic Condition
- Objectives
- Relate why growth parameters are of importance to patients with a family history of endocrine disease.
- List the symptoms of hypothyroidism in infants.
- Discuss the dietary adjustment required for a child with diabetes insipidus.
- Compare the signs and symptoms of hyperglycemia and hypoglycemia.
- Objectives *(cont.)*
- Differentiate between type 1 and type 2 diabetes.
- List three precipitating events that might cause diabetic ketoacidosis.
- List a predictable stress that the disease of diabetes has on children and families during the following periods of life: infancy, toddlers, preschool age, elementary school-age, puberty, and adolescence.
- Objectives *(cont.)*
- Outline the educational needs of the diabetic child and parents in the following areas: nutrition and meal planning, exercise, blood tests, administration of insulin, and skin care.
- List three possible causes of insulin shock.
- Explain the Somogyi phenomenon.
- Discuss the preparation and administration of insulin to a child, highlighting any differences between pediatric and adult administration.
- Endocrine System
- Two major control systems that monitor the functions of the body are the
  - Nervous system

- Endocrine system

- These systems are interdependent
- Endocrine (ductless) glands regulate the body's metabolic processes
- Primary responsibilities
  - Growth
  - Maturation
  - Reproduction
  - Response of the body to stress
- Endocrine System *(cont.)*
- Endocrine System *(cont.)*
- Hormones
  - Chemical substances produced by the glands
  - Secreted directly into the blood
  - An organ specifically influenced by a certain hormone is called a *target organ*
  - Too much or too little can result in disease
- Endocrine System *(cont.)*
- The absence or deficiency of an enzyme that has a role in metabolism causes a defect in the metabolic process
- Most inborn errors of metabolism can be detected by clinical signs or screening tests that can be performed in utero

- Lethargy, poor feeding, failure to thrive, vomiting, and an enlarged liver may be early signs of an inborn error of metabolism in the newborn

- Endocrine System *(cont.)*

- If clinical signs are not manifested in the neonatal period, an infection or body stress can precipitate symptoms of a latent defect in the older child
- Unexplained mental retardation, developmental delay, convulsions, an odor to the body or urine, or episodes of vomiting may be subtle signs of a metabolic dysfunction
- Endocrine System *(cont.)*
- Studies that can help in the diagnosis
  - Radiographic
  - Serum blood screening tests
    - Phenylketonuria (PKU)
    - Chromosomal studies
  - Tissue biopsy
  - Thyroid function
  - Ultrasound
  - 24-hour urine specimen
- Inborn Errors of Metabolism
- Tay-Sachs Disease
- Deficiency of *hexosaminidase*, an enzyme necessary for the metabolism of fats
  - Lipid deposits accumulate on nerve cells causing physical and mental deterioration
  - Primarily found in the Ashkenazic Jewish population
  - Autosomal recessive trait
- Tay-Sachs Disease *(cont.)*
- Infant appears normal until about 5-6 months of age when physical development begins to slow (head lag or an inability to sit)
- As it progresses, blindness and mental retardation develop

- Most children with Tay-Sachs die before 5 years of age due to secondary infection or malnutrition
- There is no treatment
- Nursing care is mainly palliative
- Carriers can be identified by screening tests in the first trimester
- Endocrine Disorders
- Hypothyroidism
- Deficiency in hormone secretions of the thyroid gland
- May be congenital or acquired
  - In congenital, the gland is absent or not functioning
- More common endocrine disorders in children
- Controls metabolism in the body
- Symptoms may not be apparent for many months
- Manifestations of Hypothyroidism
- Infant is very sluggish and sleeps a lot
- Tongue becomes enlarged, causing noisy respiration
- Skin is dry, no perspiration
- Hands and feet are cold
- Infant feels floppy when handled
- Chronic constipation
- Hair eventually becomes dry and brittle
- If left untreated, irreversible mental retardation and physical disabilities result

- Juvenile Hypothyroidism
- Juvenile hypothyroidism acquired by the older child
  - Most often caused by lymphocytic thyroiditis
  - Often appears during rapid growth period
- Symptoms and diagnosis similar to congenital hypothyroidism
- Because brain growth is nearly complete by 2 to 3 years of age, mental retardation and neurological complications are not seen in the older child
- Screening for Hypothyroidism
- A screening test for hypothyroidism is mandatory in the U.S. and is performed at birth
- Treatment for Hypothyroidism
- Administration of synthetic thyroid hormone
- Serum hormone levels monitored regularly
- Therapy reverses symptoms and, in the infant, prevents further mental retardation but does not reverse existing retardation
- Children may experience temporary, reversible hair loss, insomnia, aggressiveness, and their schoolwork may decline during the first few months of therapy
- Hormone replacement for hypothyroidism is lifelong
- Treatment for Hypothyroidism *(cont.)*
- Signs of too much thyroid replacement
  - Rapid pulse rate
  - Dyspnea
  - Irritability
  - Weight loss

- Sweating

- Signs of too little thyroid replacement
  - Fatigue
  - Sleepiness
  - Constipation
- Parents should be instructed about both
- Diabetes Insipidus
- Diabetes Insipidus: Pituitary Gland (Anterior)
- Diabetes Insipidus: Pituitary Gland (Posterior)
- Parathyroid Gland Disorders
- Adrenal Gland Disorders
- Diabetes Mellitus (DM)
- Chronic metabolic syndrome—the body is unable to use carbohydrates properly
  - Leads to impairment of glucose transport
- Body unable to store and use fats properly
- Decrease in protein synthesis
- When blood glucose level becomes dangerously high
  - Glucose spills into the urine
  - Diuresis occurs
- Diabetes Mellitus (DM) *(cont.)*
- Incomplete fat metabolism produces ketone bodies that accumulate in the blood

- Known as ketonemia
  - Serious complication

- DM impacts physical and psychological growth and development of children
- Treatment designed to
  - Optimize growth and development
  - Minimize complications
- Diabetes Mellitus (DM) *(cont.)*
- Long-term complications related to hyperglycemia
  - Blindness
  - Circulatory problems
  - Kidney disease
  - Neuropathy
- Classifications of DM
- Type 1 Diabetes Mellitus (DM)
- Can occur at any time in childhood, new cases highest among
  - 5- and 7-year-olds: Stress of school and increased exposure to infectious diseases may be a triggering factor
  - 11- to 13-year-olds: During puberty, rapid growth, increased emotional stress, and insulin antagonism of sex hormones may be implicated
- More difficult to manage in childhood because of growing, energy expenditure, varying nutritional needs
- Initial diagnosis may be determined when the child develops ketoacidosis
- Manifestations of Type 1 DM
- Classic triad of symptoms

- Polydipsia
- Polyuria
- Polyphagia

- Symptoms appear more rapidly in children
- Insidious onset with lethargy, weakness, and weight loss also common
- Skin becomes dry
- Vaginal yeast infections may be seen in the adolescent girl
- Laboratory Findings in Type 1 DM
- Glucose in urine (glycosuria)
- Hyperglycemia
  - Occurs because glucose cannot enter the cells without the help of insulin; glucose stays in bloodstream
- Cells use protein and fat for energy
  - Protein stores in body are depleted
  - Lack of glucose in cells triggers polyphagia
- Increase in glucose intake further increases glucose levels in the blood
- Honeymoon Period of Type 1 DM
- After initially diagnosis, the child is stabilized by insulin dosage and condition may appear to improve
  - Insulin requirements decrease, child feels well
  - Supports parents' phase of "denial"
- Lasts a short time; therefore, parents must closely monitor blood glucose levels to avoid complications

- Diagnostic Tests for DM
- Random blood glucose
  - Blood is drawn at any time, no preparation; results should be within normal limits for both diabetic and nondiabetic patients
- Fasting blood glucose
  - If greater than 126 mg/dL on two separate occasions, and the history is positive, patient is considered as having DM and requires treatment
- Glucose tolerance test
  - Blood glucose level above 200 mg/dl is considered positive
- Glycosylated hemoglobin (HbA1c):
  - Values of 6% to 9% represent very good metabolic control
  - Values above 12% indicate poor control
- Diabetic Ketoacidosis (DKA)
- Also referred to as *diabetic coma*, even though patient may not be in one
- May results from a secondary infection and patient does not follow proper self-care
- May also occur if disease proceeds unrecognized
- Ketoacidosis is the end result of the effects of insulin deficiency
- Diabetic Ketoacidosis (DKA) *(cont.)*
- Signs and symptoms include
  - Ketonuria
  - Decreased serum bicarbonate concentration (decreased CO_2 levels) and low pH
  - Hypertonic dehydration
  - Fruity odor to breath
  - Nausea
  - ALOC

- Symptoms range from mild to severe
  - Occur within hours to days
- Treatment Goals of DM
- Ensure normal growth and development through metabolic control
- Enable child to cope with a chronic illness, have a happy and active childhood, and be well-integrated into the family
- Prevent complications through tight blood glucose control
- Nursing Care of a Child with DM
- Parent and child education
  - Patient's age, financial, educational, cultural, and religious situations must be considered when developing a teaching plan
    - For example, pork-based insulin may not be accepted by some religions; therefore, compliance with treatment may be reduced
- Nursing Care of a Child with DM *(cont.)*
- Children with DM are growing, additional dimensions of the disorder and its treatment become evident
  - Growth is not steady
  - Occurs in spurts and plateaus that affect treatment
  - Infants and toddlers may have hydration problems
  - Preschool children have irregular activity and eating patterns
  - School-age children may grieve over the diagnosis
  - May use illness to gain attention or to avoid responsibilities
  - Onset of puberty may require insulin adjustments
  - Adolescents often resent this condition and may have more difficulty in resolving conflict between dependence and independence; may lead to rebellion against parents and treatment regimen
- Triad of Management for DM

- Well-balanced diet
- Precise insulin administration
- Regular exercise
- Teaching Plan for a Child with DM
- Physiology of the pancreas and its function
- Function of insulin
- Blood glucose self-monitoring
- Diet therapy (glycemic index of foods and cholesterol intake)
- Insulin management
- Exercise
- Skin care
- Foot care
- Infections
- Emotional upsets
- Urine check
- Glucose-insulin imbalances
- Travel
- Follow-up care
- Illness or surgery
- Nutritional Management of DM
- Ensure normal growth and development

- Distribute food intake so that it aids metabolic control
- Individualize the diet in accordance with the child's ethnic background, age, sex, weight, activity, family economics, and food preferences
  - Total estimated caloric intake is based upon body size or surface area
  - Most carbohydrate intake should consist of complex carbohydrates that absorb slowly and do not cause sudden and wide elevation of blood glucose
- Dietary Fiber and DM
- Soluble fiber has been shown to
  - Reduce blood glucose levels
  - Lower serum cholesterol values
  - Sometimes reduce insulin requirements
- Fiber appears to slow the rate of absorption of sugar by the digestive tract
- Safety Alert
- Instruct the patient and family to read food labels carefully
  - The word *dietetic* does not mean *diabetic*
  - Dietetic merely means something has been changed or replaced
    - For example, the food may contain less salt or less sugar
- Insulin Administration
- Teach parents and child
- Insulin cannot be taken orally because it is a protein and would be broken down by the gastric juices
- Usual method of administration is subcutaneously
- Insulin Administration *(cont.)*
- In general, a child can be taught to perform self-injection after 7 years of age

- Insulin Administration *(cont.)*
- Sites of injections are rotated to prevent poor absorption and injury to tissue
  - Lipoatrophy can occur if sites are not rotated
- Should not inject into areas that would have a temporarily increased circulation, such as in a child pedaling a bike, you would not inject into the leg
- Mixing Insulin
- Insulin
- Main difference is in the amount of time required for it to take effect and the length of protection time
  - The response to any given insulin dose is highly individualized and depends on may factors, such as site of injection, local destruction of insulin by tissue enzymes, and insulin antibodies
- Insulin can also be given through a pump device
- Insulin Shock
- Also known as *hypoglycemia*
- Blood glucose level becomes abnormally low
- Caused by *too much* insulin
- Factors
  - Poorly planned exercise
  - Reduced diet
  - Errors made because of improper knowledge of insulin and the insulin syringe
- Insulin Shock *(cont.)*
- Children are more prone to insulin reactions than adults because
  - The condition itself is more unstable in young people

- They are growing
- Their activities are more irregular

- Symptoms of insulin reaction
  - Irritable
  - May behave poorly
  - Pale
- May complain of feeling hungry and weak
- Sweating occurs
- CNS symptoms arise because glucose is vital to proper functioning of nerves
- Insulin Shock *(cont.)*
- Immediate treatment
  - Administering sugar in some form, such as orange juice, hard candy, or a commercial product
  - Begins to feel better within a few minutes and then may eat a small amount of protein or starch to prevent another reaction
  - Glucagon is recommended in cases of severe hypoglycemia
- Somogyi Phenomenon
- Rebound hyperglycemia
- Blood glucose levels are lowered to a point at which the body's counter-regulatory hormones (epinephrine, cortisol, glucagon) are released
- Glucose is released from muscle and liver cells which leads to a rapid rise in blood glucose levels
- Somogyi Phenomenon *(cont.)*
- Generally the result of chronic insulin use, especially in patients who required fairly large doses of insulin to regulate their blood sugars

- Hypoglycemia during the night and high glucose levels in the morning are suggestive of the phenomenon
- Child may need less insulin, not more, to rectify the problem
- Somogyi Phenomenon *(cont.)*
- Differs from the *dawn phenomenon* in which early morning elevations of blood glucose occur *without* preceding hypoglycemia but may be a response to growth hormone secretion that occurs in the early morning hours
- Together the Somogyi and dawn phenomena are the most common causes of instability in diabetic children
- Type 2 Diabetes Mellitus (DM)
- Thought to be precipitated by
  - Obesity
  - Low physical activity
  - Lipid-rich diet resulting in insulin resistance
- Diet is main emphasis of management along with exercise and other weight control measures
- Insulin, oral hypoglycemic medications contribute to stable control of blood glucose level
- Question for Review
- What is the difference between a blood glucose level and an $HgbA_{1c}$ level, as seen in the lab report of a child with diabetes mellitus?
- Review
- Objectives
- Key Terms
- Key Points

- Online Resources
- Review Questions